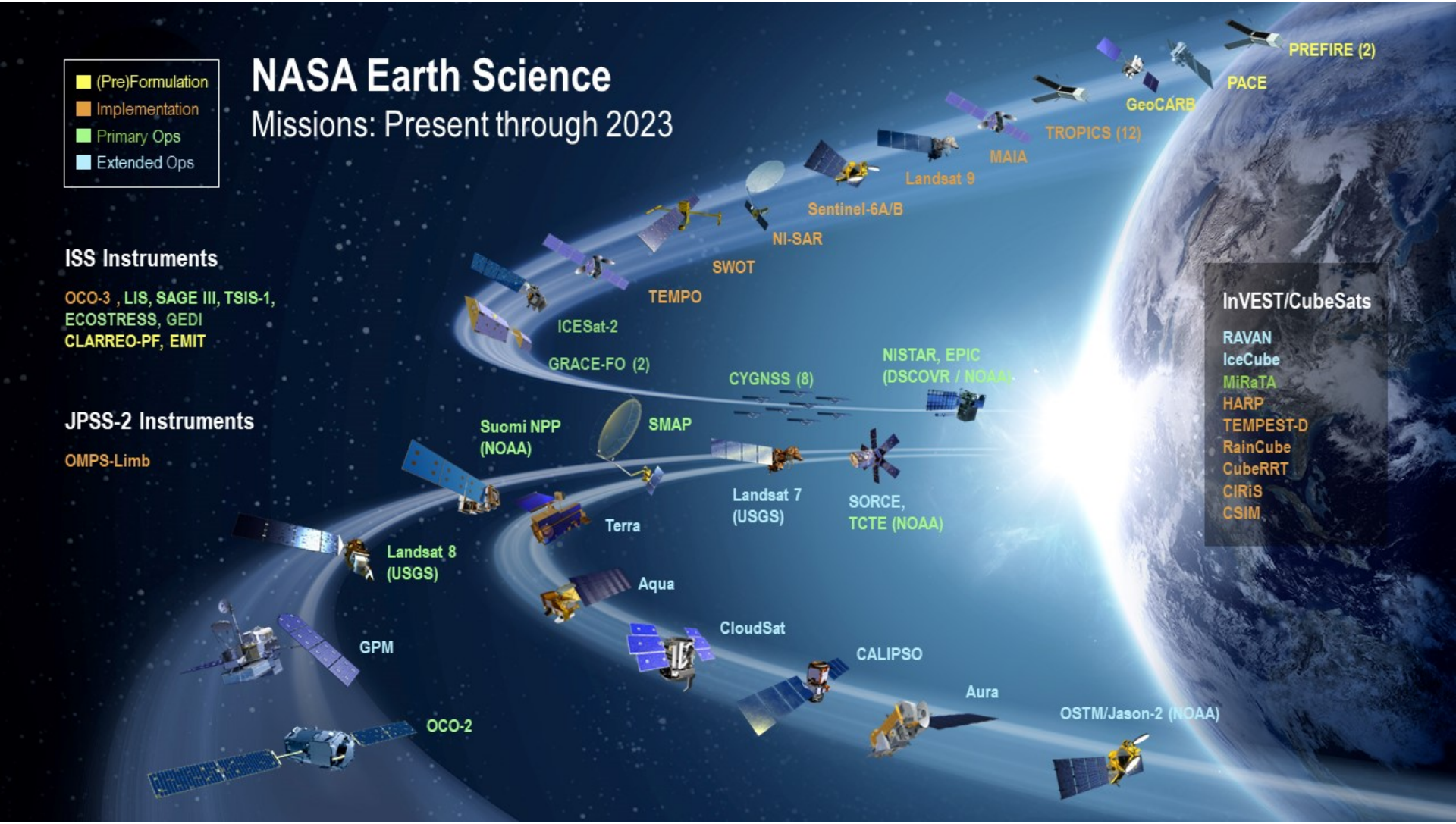
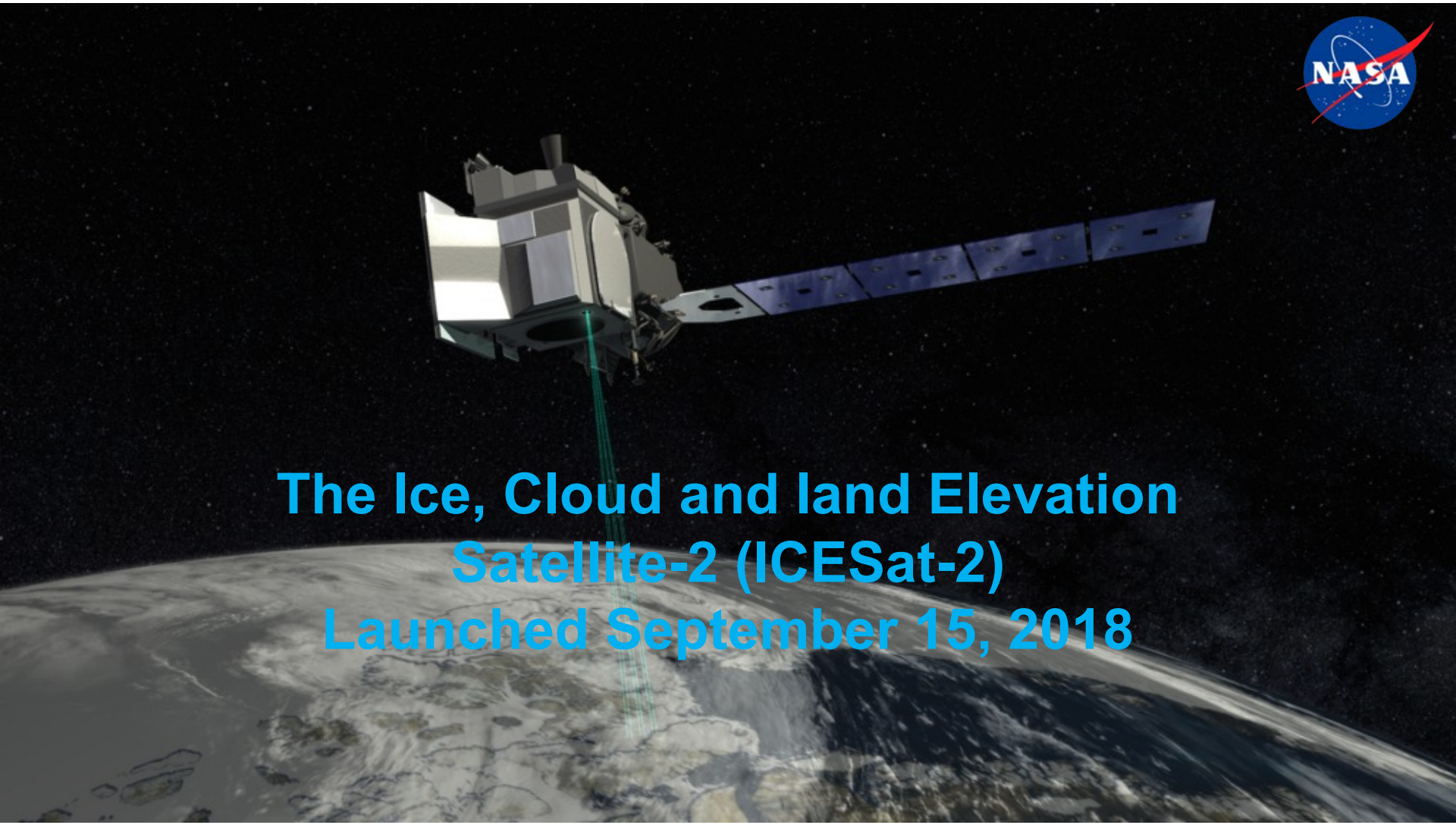
Students, Teachers, Citizen Scientists, and NASA Observing the Height of Our Planet, One Tree at a Time

23rd GLOBE Annual Meeting
Detroit, Michigan USA
18 April 2019

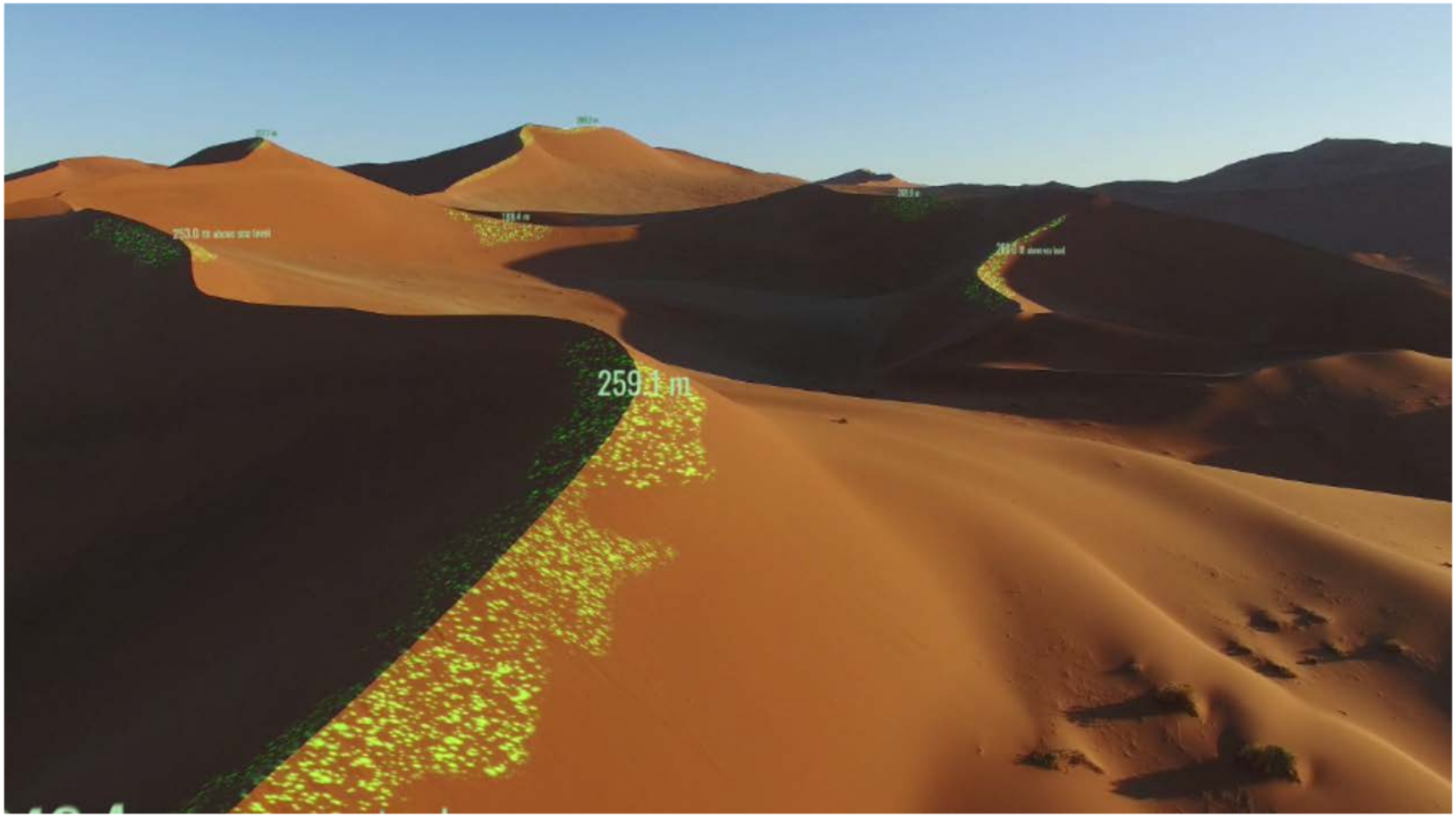
Brian A. Campbell
NASA Senior Earth Science Outreach Specialist
NASA GLOBE Observer Trees Science Lead
ICESat-2 Education Lead
NASA Wallops Flight Facility


(Pre)Formulation
Implementation
Primary Ops
Extended Ops
NASA Earth Science
Missions: Present through 2023
ISS Instruments
OCO-3 , LIS, SAGE III, TSIS-1,
ECOSTRESS, GEDI
CLARREO-PF, EMIT
JPSS-2 Instruments
OMPS-Limb
PREFIRE (2)
PACE
GeoCARB
TROPICS (12)
MAIA
Landsat 9
Sentinel-6A/B
NI-SAR
SWOT
TEMPO
ICESat-2
GRACE-FO (2)
CYGNSS (8)
NISTAR, EPIC
(DSCOVR / NOAA)
Suomi NPP
(NOAA)
SMAP
Landsat 7
(USGS)
SORCE,
TCTE (NOAA)
Terra
Landsat 8
(USGS)
Aqua
CloudSat
CALIPSO
Aura
OSTM/Jason-2 (NOAA)
GPM
OCO-2
InVEST/CubeSats
RAVAN
IceCube
MiRaTA
HARP
TEMPEST-D
RainCube
CubeRRT
CIRiS
CSIM

THE MISSIONS

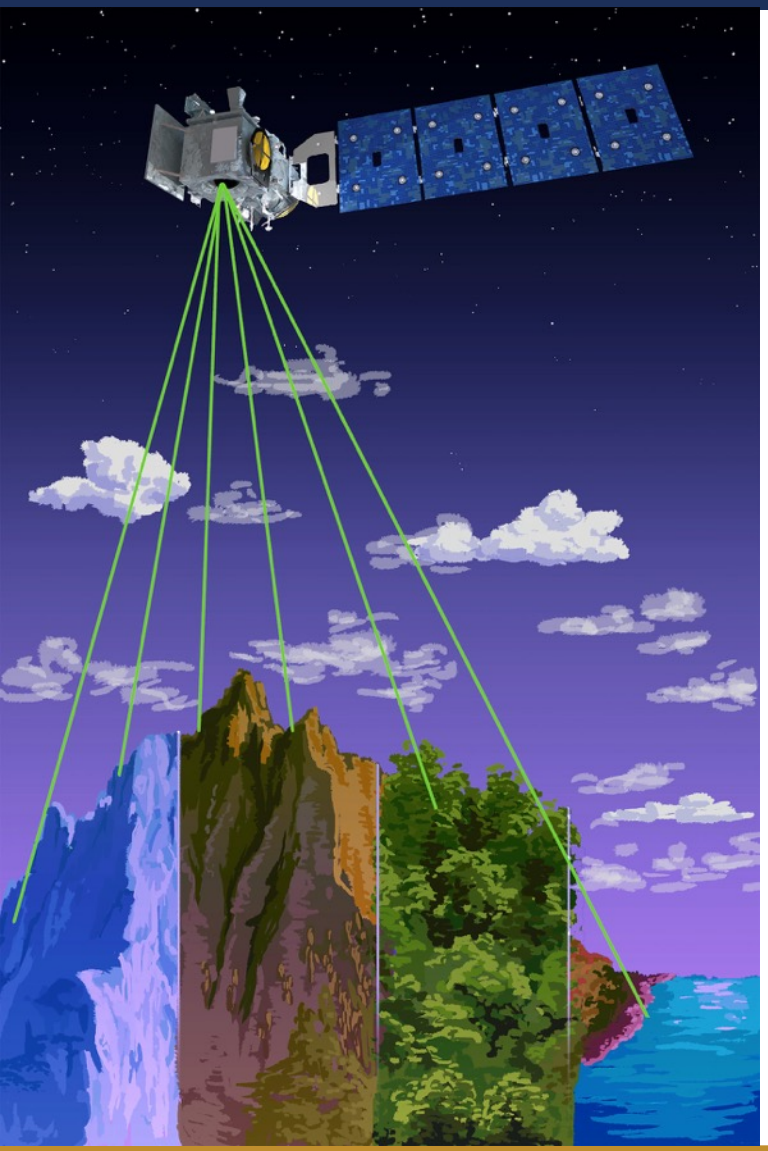


The Ice, Cloud and land Elevation Satellite-2 (ICESat-2) Launched September 15, 2018

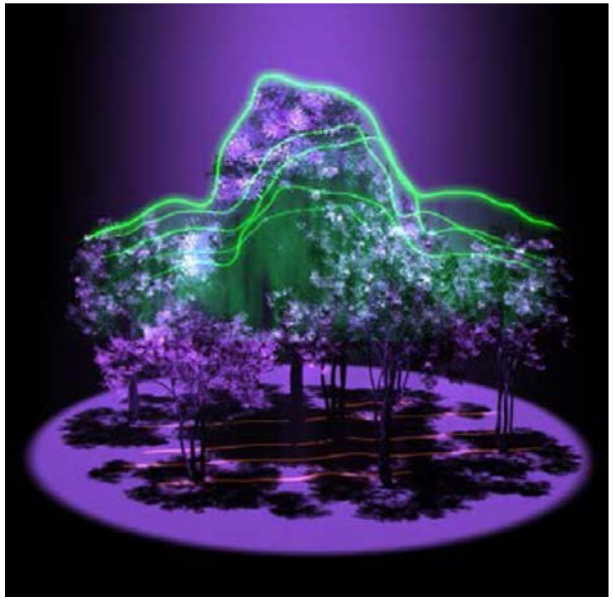


ICESat-2 Elevates Our World (video):

https://icesat-2.gsfc.nasa.gov/sites/default/files/videos/original/12663_ICESat2_Height.mp4



The ICESat-2 Satellite uses an onboard laser altimeter system to measure the height of our planet, including trees.



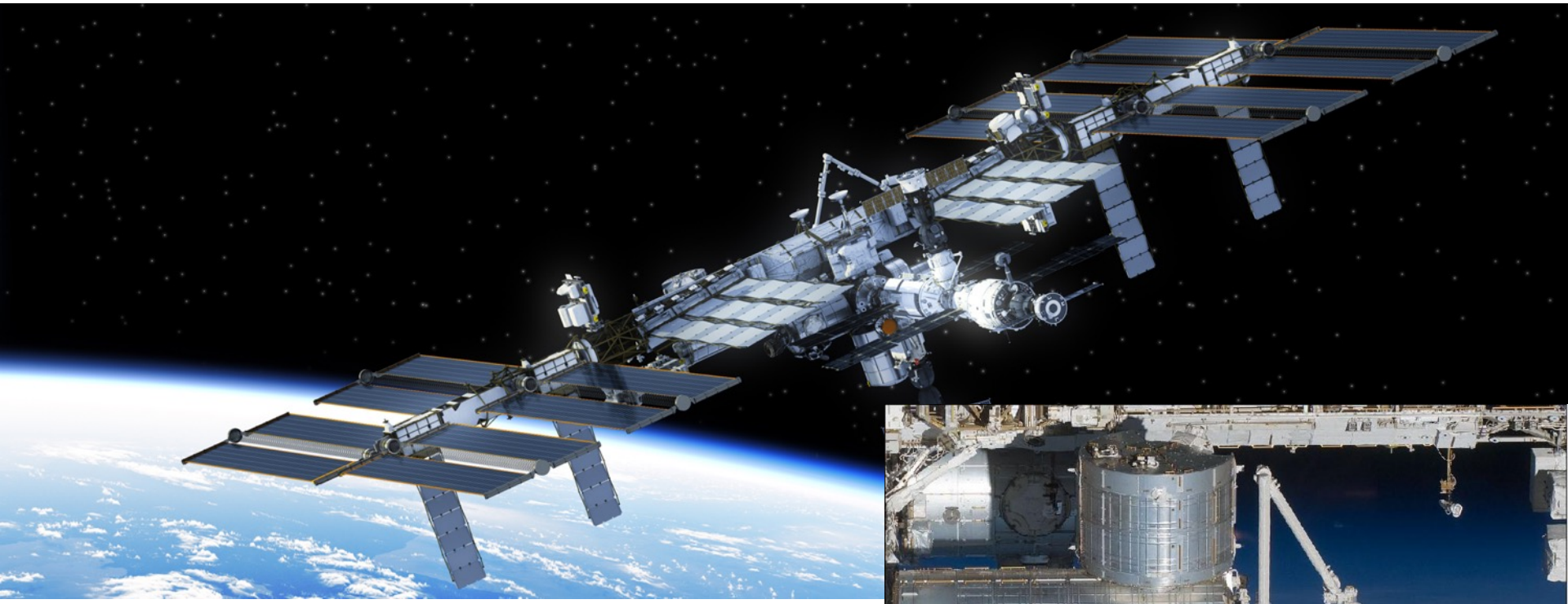
ICESat-2 By The Numbers (video):

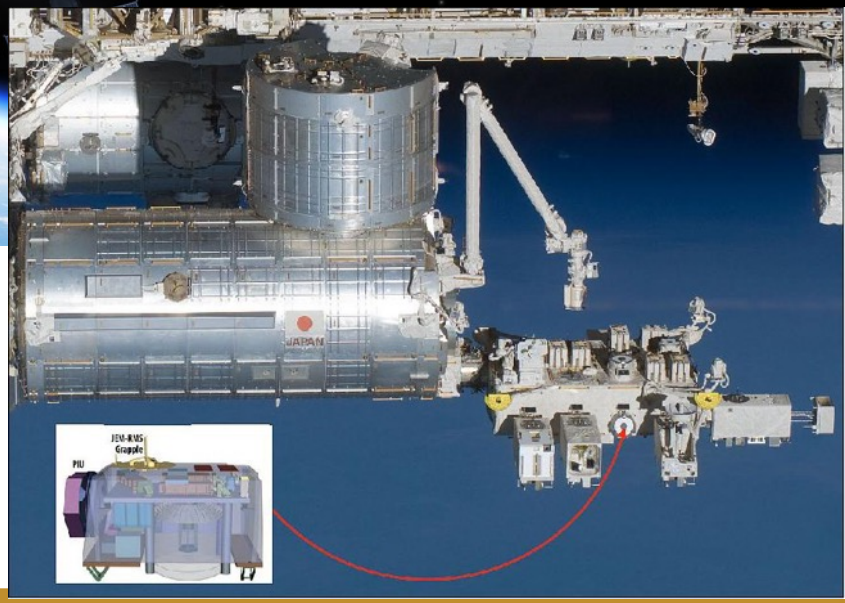
https://icesat-2.gsfc.nasa.gov/sites/default/files/videos/original/12768_300Trillion.mp4

"May the Forest be with You!"

GEDI Mission (video):

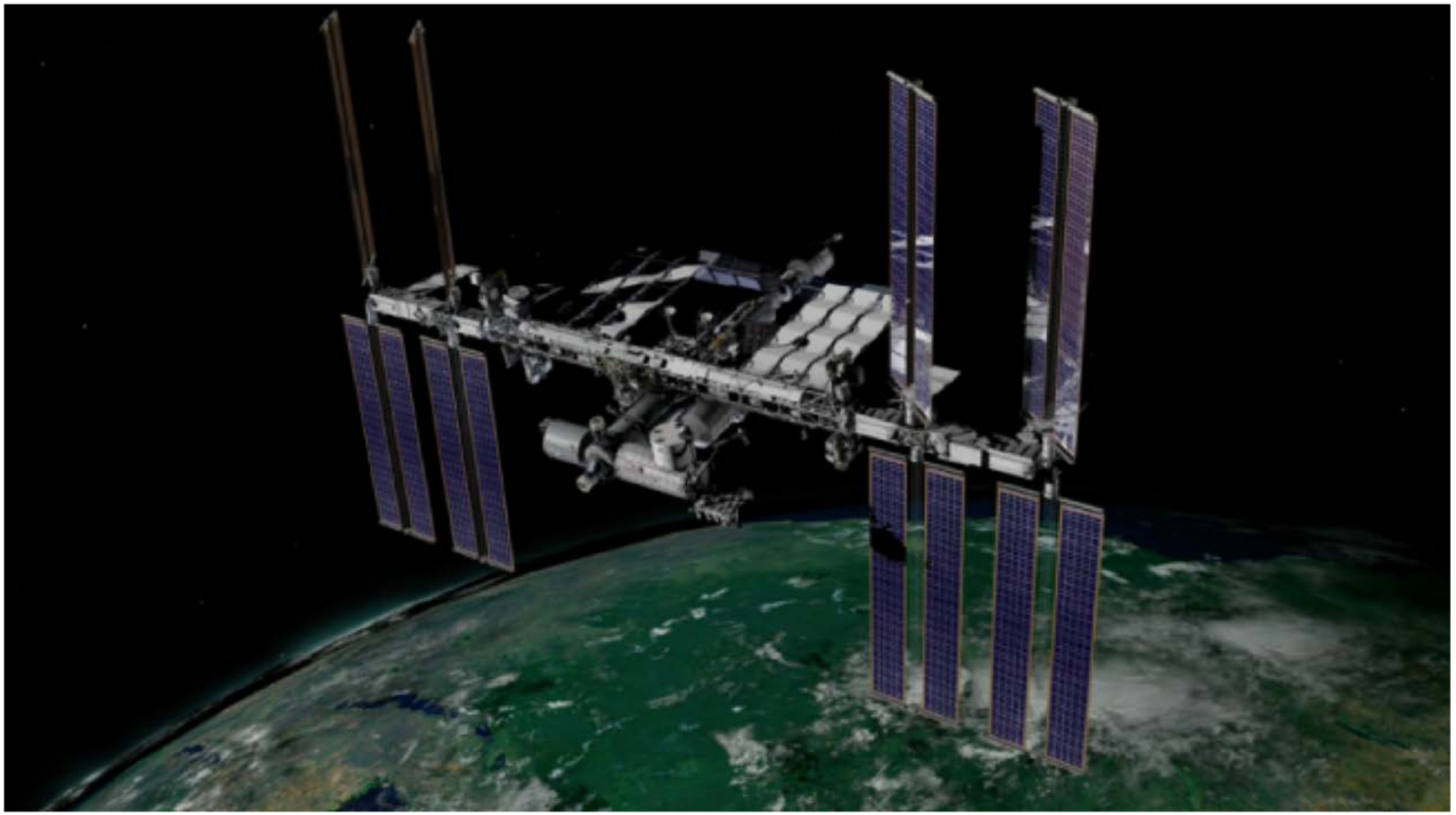
https://svs.gsfc.nasa.gov/vis/a010000/a012900/a012939/FACEBOOK_720_GEDI_Star_Wars_Day_V9_facebook_720.mp4





The Global Ecosystem Dynamics Investigation (GEDi) on ISS

Launched December 5, 2018



(GEDi) on ISS Overview (Video):

https://svs.gsfc.nasa.gov/vis/a010000/a013000/a013090/GEDI_beauty_waveform_youtube_720.mp4

WHAT IS GLOBE

The **GLOBE** Program

#GLOBE23

GLOBE by the Numbers

121	Countries
35,374	Schools
36,344	Teachers
147,964	GLOBE Observers
168,590,596	Measurements
38,251	Measurements this month

View GLOBE Countries >

Sponsored by: NASA Supported by: NSF NOAA

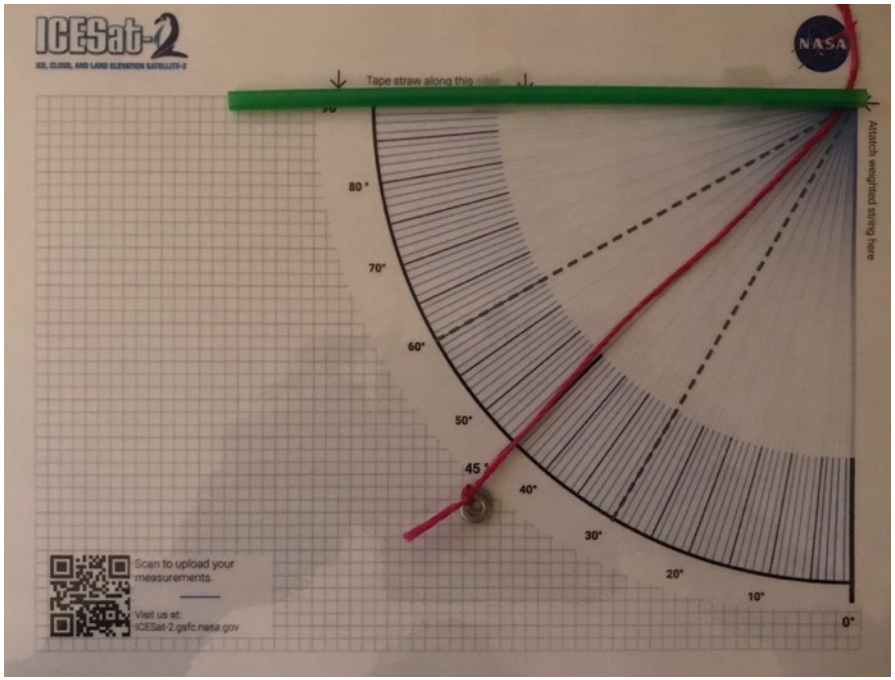
Implemented by: UCAR

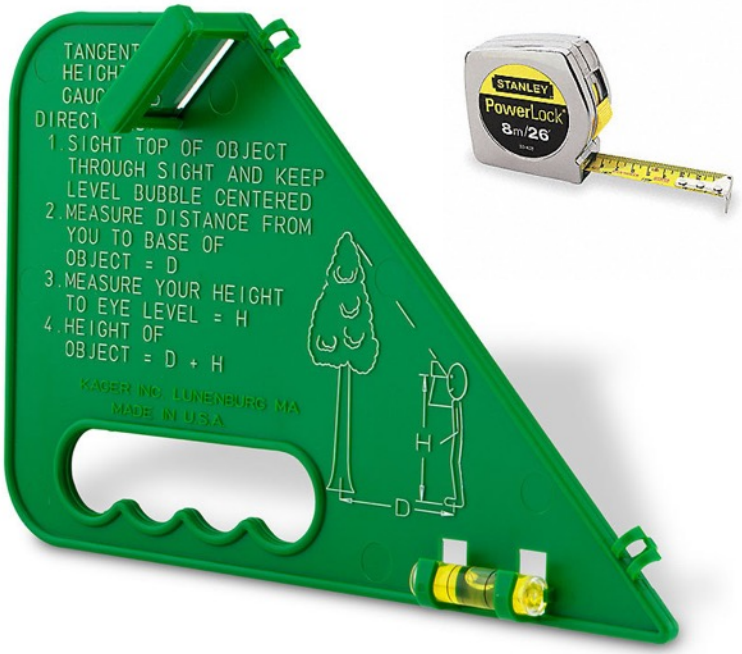
THE CAMPAIGN

Trees Around the GLOBE Student Research Campaign

The Trees Around the GLOBE Campaign began on September 15, 2018 in conjunction with NASA's ICESat-2 satellite launch on the same date at 6:02am PDT. This campaign is a student research campaign focusing on tree height - one of the measurements conducted by the ICESat-2 mission. We also focus on Land Cover and Greenings protocols.

The Tools – Clinometers and Tape Measure





Left is the GLOBE Program's Paper Clinometer
Right is a store-bought plastic clinometer

Guiding Investigative Questions for Data Collection and Research

- Where are trees growing and why are they there?
- What can measuring tree height tell us about our local ecosystem?
- What is the relationship between tree height and land cover?
- What are the tools for measuring trees and

Campaign Metrics since 9/15/18

6,500+ Tree Height Measurements

6,400+ Green Up/Green Down Measurements

5,500+ Land Cover Measurements

11 webinars (10 campaign specific, 1 FB Live)

505 direct participants from 26 countries

22 blogs with 16,000+ views

62 uploaded documents

4 IVSS Projects related to campaign

TREES AROUND THE GLOBE STUDENT RESEARCH CAMPAIGN

https://www.globe.gov/web/trees-around-the-globe

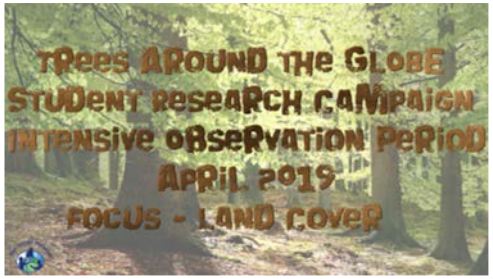
Tree Height Measurements

GET STARTED AT

https://www.globe.gov/web/trees-around-the-globe/overview

Some guidelines for choosing trees to measure:

1. Trees measured should be at least 5m (16.4ft) tall;
2. Trees measured should be isolated trees or the tallest trees in a large grouping of trees



THE CITIZEN SCIENCE TREES TOOL

NASA GLOBE Observer Trees Tool Promo (Video)

https://www.youtube.com/watch?v=uc11s19OidQ

The Tools – Mobile Device and Tape Measure

NASA Trees (Tree Height)
http://observer.globe.gov
Released March 26, 2019


NASA
Every time you take a breath, thank a Tree.
GLOBE Observer

A Few Screen Shots

GLOBE Observer

Choose your protocol:

Trees

mosquito habitat mapper

Land Cover
Adopt a Pixel

Visit the Website

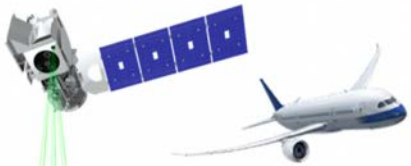
●○○○○ AT&T 9:28 AM 100%

Benefits

Recording tree height can help:

Track how trees are changing over time, and can help estimate the number of trees that make up an area.

Serve as a step to help scientists and researchers understand how trees help us balance Earth's carbon budget.



NASA has many satellites, airborne missions, and instruments, like ICESat-2, GEDI, G-LiHT, and others that measure Earth's height from space, including tree height. Citizen Science tree height observations provide useful data for scientists to compare to what the satellites, airborne missions, and instruments are observing.

Record the height of trees in as many places you would like and scientists can use that information to improve their accuracy.

Next

Notification My Map Help

●○○○○ AT&T 9:28 AM 100%

Observations: 189

New Trees Observation

Review / Send My Trees Observations

Where to Observe?

See My Data

Location

Remain standing at the base of the tree, while your location is recorded.

Latitude: 34.1464

Longitude: -118.1325

Use 2 fingers to move map

Location accuracy is important -- and should improve as you wait. If possible, accuracy should be under 170 feet. You may also drag the map to refine your location.

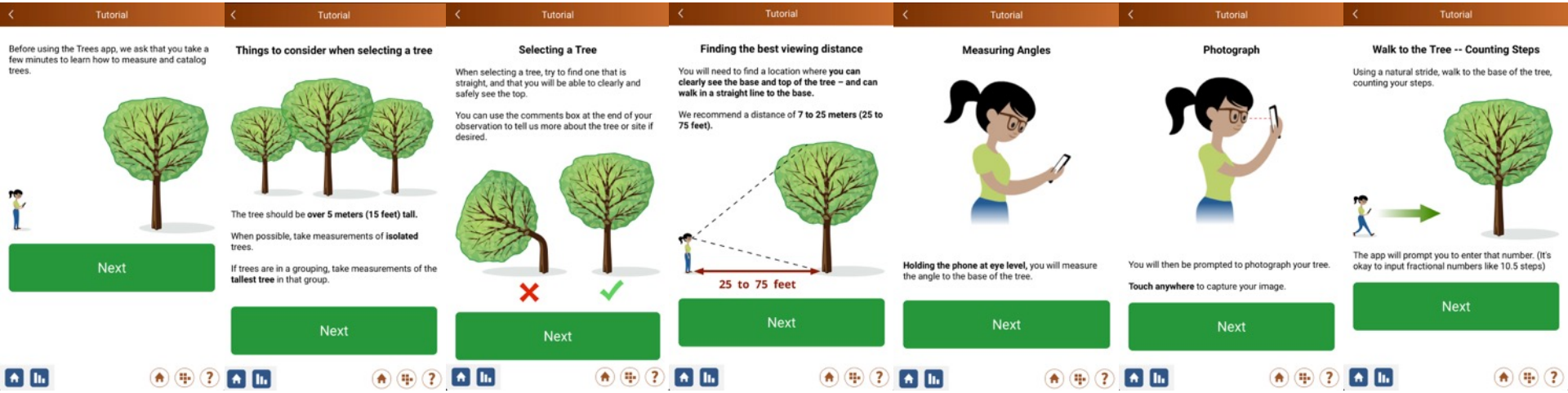
Measure Angle to your Starting Position (optional)

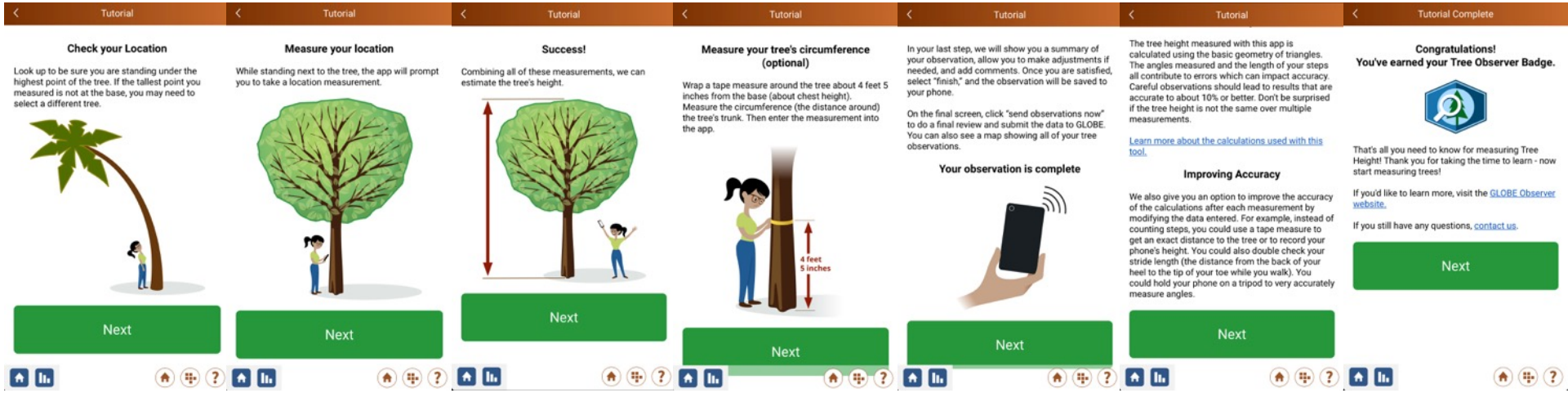
Enter Tree Characteristics (optional)

Skip and Review Data

Notification My Map Help

A Tutorial to Make it Easier



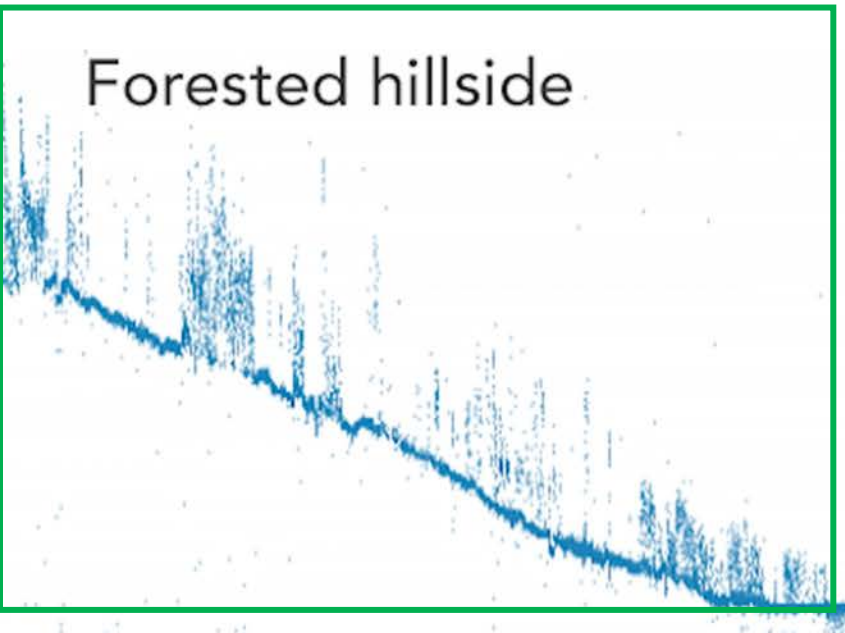


A WORK IN PROGRESS!

LOOKING AND COMPARING THE DATA AT OPEN ALTIMETRY

WWW.OPENALTIMETRY.ORG

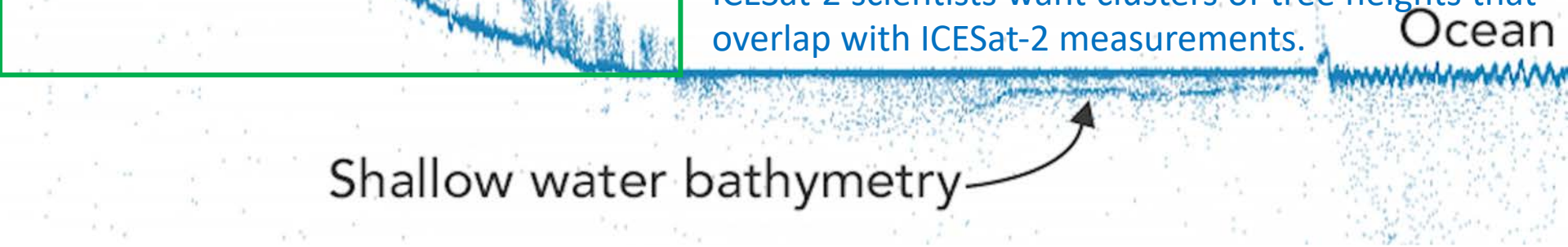
What Kind of Tree Height Data Do The ICESat-2 Scientists Want?



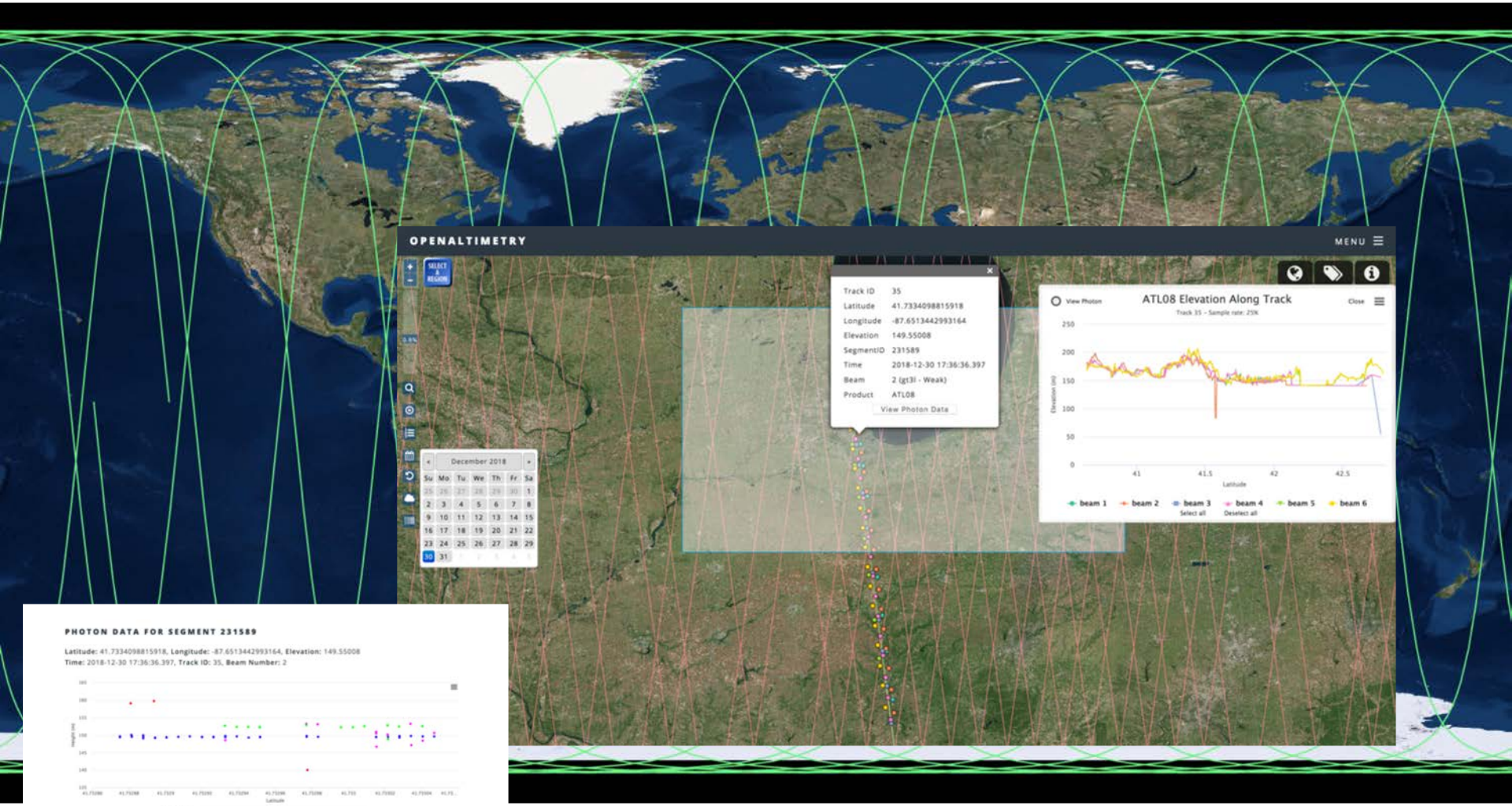
Each dot represents a photon that has left the satellite, bounced off the Earth and returned to the satellite.

Note the density of the photon data the make up the profiles of the trees. This density allows for a more accurate height measurement.

ICESat-2 scientists want clusters of tree heights that overlap with ICESat-2 measurements.



Our Ultimate Goal is to Compare the Satellite Tree Height Data to the GLOBE Student and NASA GO Tree Height Data


OPENALTIMETRY
MENU
SELECT A REGION
Track ID 35
Latitude 41.7334098815918
Longitude -87.65134442993164
Elevation 149.55008
SegmentID 231589
Time 2018-12-30 17:36:36.397
Beam 2 (gt3l - Weak)
Product ATL08
View Photon Data
December 2018
View Photon
ATL08 Elevation Along Track
Track 35 - Sample rate: 25%
Close
beam 1
beam 2
beam 3
beam 4
beam 5
beam 6
Select all
Deselect all
PHOTON DATA FOR SEGMENT 231589
Latitude: 41.7334098815918, Longitude: -87.65134442993164, Elevation: 149.55008
Time: 2018-12-30 17:36:36.397, Track ID: 35, Beam Number: 2

Shumate Middle School / ICESat-2 - Tree Height Comparisons

Lilyannah Dunigan, Thomas Hamilton, Brady Jaskula

Shumate Middle School – Gibraltar School District
Gibraltar, Michigan (United States of America)

Abstract

This research study was conducted by Shumate Middle School students Lilyannah Dunigan (Sixth Grade), Thomas Hamilton (Eighth Grade), and Brady Jaskula (Seventh Grade). Shumate Middle School (Gibraltar School District) is located in Gibraltar, Michigan (United States of America). For this project, we chose to measure the tree height of various trees found on the Shumate Middle School campus. Our goal was to compare our average tree height measurements to the tree height measurements taken by NASA's ICESat-2 satellite. Our hypothesis for this project is we believe that the our tree height measurements will be close to the tree height measurements taken by the ICESat-2 satellite, and vary by no more than 1 meter in length. We collected tree height data from September 2018 through March 2019. All data was uploaded to the GLOBE Program's website, and shared with various scientists from around the world. However, our group was not able to compare our average tree height measurements to that of the ICESat-2 satellite as the ICESat-2 data was not readily available at the time of this report. Please enjoy the tree height measurements taken by our research team.

Research Question

Our research team decided to measure the heights of various trees found on the Shumate Middle Campus for this environmental study. Last year, group members Thomas Hamilton and Brady Jaskula were involved in a GLOBE Program tree height measuring pilot program at Shumate Middle School. To build upon the work started last year, our group decided to continue identifying and measuring trees on our campus and to help calibrate the recently launched NASA ICESat-2 satellite. With this in mind, we developed our research question, ***"How close are the average tree height measurements taken at Shumate Middle School in comparison to the tree height measurements taken by the ICESat-2 satellite?"***

Introduction

According to the GLOBE Program's Biometry - Graminoids, Tree Height and Shrubs training module, it is important to measure trees as this allows us to assess various land cover on our planet.

Hypothesis:

We believe our average tree height measurements will align closely to the measurements taken by the ICESat-2 satellite and vary by no more than 1 meter in length. It is our belief that our measurements will be accurate as we have good tools and technology needed to take accurate and precise measurements.

GLOBE BADGES

We would like to apply for the following GLOBE International Virtual Science Symposium Badges:

- **Collaborator** - During our research, we connected with Mr. Brian Campbell (NASA and The GLOBE Program). We discussed how to take accurate tree height measurements. We also discussed how our tree height measurements help calibrate the ICESat-2 satellite.
- **Make an Impact** - We hope that NASA will utilize our tree height measurements to help calibrate the ICESat-2 satellite. Additionally, during our measurement campaign, our group shared our tree height measurement best practices during a December 3, 2018 GLOBE webinar called "Trees Around the GLOBE Student Research Webinar - Getting Tree Science Done: Live From Shumate Middle School in Gibraltar, Michigan." We hope that other schools will learn from our methods.

Research Methods

Study Site:

Shumate Middle School – Gibraltar, Michigan (United States of America)

Latitude 42.065501, Longitude -83.21121, Elevation 176.7m

"The red "X's" indicate trees that were measured in this study."

GLOBE Protocols Utilized in this Study:

- Biosphere - Biometry - Graminoid, Tree and Shrub Height Protocol
- Study Sites - Shumate Middle School Campus
  - Please see GLOBE Study Sites below.
- Time Frame - Wednesday, September 19th, 2018 - Friday, March 1st, 2019

Materials:

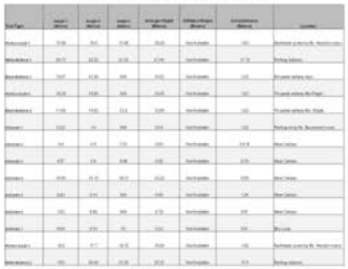
- Clinometer - Used to measure a 45 degree angle required for tree height measurement.
- Komelon 300 Foot Tape Measure - Used to measure distance from tree.
- Plastic Stake - Used to hold the Komelon 300 foot measuring tape in an exact location while taking measurements.
- Stanley Measuring Tape - Used to to find the distance from the clinometer to the ground.
- Forest Tree Identification App - Used to help identify trees.
- Data Sheet - Used to record the data that is collected.
- Pencil/Pen - Used to record data.
- Google Chromebook - Used to send the data to the GLOBE Program and store the data on a Google Spreadsheet.

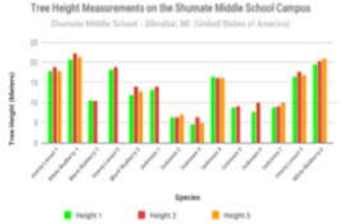
Methods:

- Gather your tools (clinometer, plastic stake, Komelon 300 ft tape, Stanley measuring tape, data sheet, pencil or pen).
- Travel to the tree that your GLOBE group has decided to measure.
- As a group, decide what part of the tree is the highest.
- Using the clinometer, look up until the top and bottom rings line up with the highest point. Make sure the clinometer is level at a 45-degree angle.
- Next, use the Stanley tape measure to measure the height of the clinometer to the ground. Record this measurement.
- Place the plastic stake in the ground where you were standing.
- Put the ring at the end of the Komelon measuring tape on the plastic stake.
- Pull Komelon tape measure to the base of the tree. Record this measurement.
- Next, use the Komelon measuring tape to measure the circumference of the tree base. Record this measurement.
- Repeat this process two more times (taking three measurements in all).
- Use the Forest Tree identification app to identify the tree. Record the genus, species, and common name.
- Collect your tools and return to the classroom. Put the tools away.
- Finally, submit the tree height data to the GLOBE Program's website and store the data on the team's Google Spreadsheet.

Results

Data Table - All Tree Height Data Collected





Tree Height Measurements Tools

Discussion

Overall, we believe that our study went well despite the fact that we could not compare our data to ICESat-2. Our group was able to measure 14 trees on our campus. We are also happy that our individual tree measurements did not vary that much from each other. This leads us to believe that our measurements were accurate.

Our group was unable to find a school for comparison purposes for our study. As previously stated, the ICESat-2 satellite tree height data is not readily available for public use (B. Campbell, personal communication, March 25, 2019). Our group can access tree height data collected by Citizen Scientists via the GLOBE Program's website. However, similar to our current situation, we would not be able to view a comparison of average tree height measurements (ground-truthing) collected by scientists to the tree height measurements taken by ICESat-2.

Our research team intends to continue our research for the remainder of the school year and throughout the summer. We have two goals that we'd like to accomplish. First, when available, we'd like to compare our measurements to those taken by the ICESat-2 satellite. Again, this will help us determine if we are taking accurate measurements. Secondly, we plan to use the GLOBE Observe app and the new Trees measuring program. We will continue to take measurements using the clinometer, Komelon 300 foot tape measure, and the Stanley tape measure. However, we will use the GLOBE Observer app to help verify the accuracy of our measurements.

Conclusions

In conclusion, we were unable to determine if our hypothesis was correct as the ICESat-2 data was unavailable. Had the ICESat-2 data been readily available, our group would have included this in the ICESat-2 Height (Meters) column of our data table (see Data Table 1). We would have also calculated the difference between our average tree height and the ICESat-2 data. Again, this information would have been provide in the data table. To make use of data, we compared the average tree height measurements of the various trees we measured on the Shumate Middle School campus. Additionally, we found out that mulberry and locust trees are common on our campus.

To prepare this research report, our team had to stop taking average tree height measurements at the end of March 2019. We wish we would have been able to identify the unknown trees and include more tree height measurements in this study.

Bibliography

Boger, R., and Low, R. (2016) The GLOBE Program - Biosphere - Biometry Protocol - Graminoid, Tree and Shrub Height [PowerPoint slides]. Retrieved from https://www.globe.gov/get-trained/protocol-training/training-modules/16867717/3099387

Campbell, B. (2018, December 3).Trees Around the GLOBE Webinar 4 on December 3 2018. Retrieved from https://www.youtube.com/watch?v=yTeQ2ufiDhU

Talking Points, with your students, why measuring tree height is important

- Tree height allows you to track the growth of trees over time
- Tree height is the most widely used indicator of a ecosystem's ability to grow trees
- Tree height allows NASA scientists to understand the gain or loss of biomass which can inform calculations of the carbon that trees and forests either take in from or release into the atmosphere.
- NASA GLOBE Observer Tree height data can serve as a source of data comparison for the ICESat-2 satellite.
- ICESat-2 utilizes an onboard laser altimeter system to measure the height of our planet, one photon at a time. The technology of ICESat-2 can measure the height of trees all around our planet.

Resources

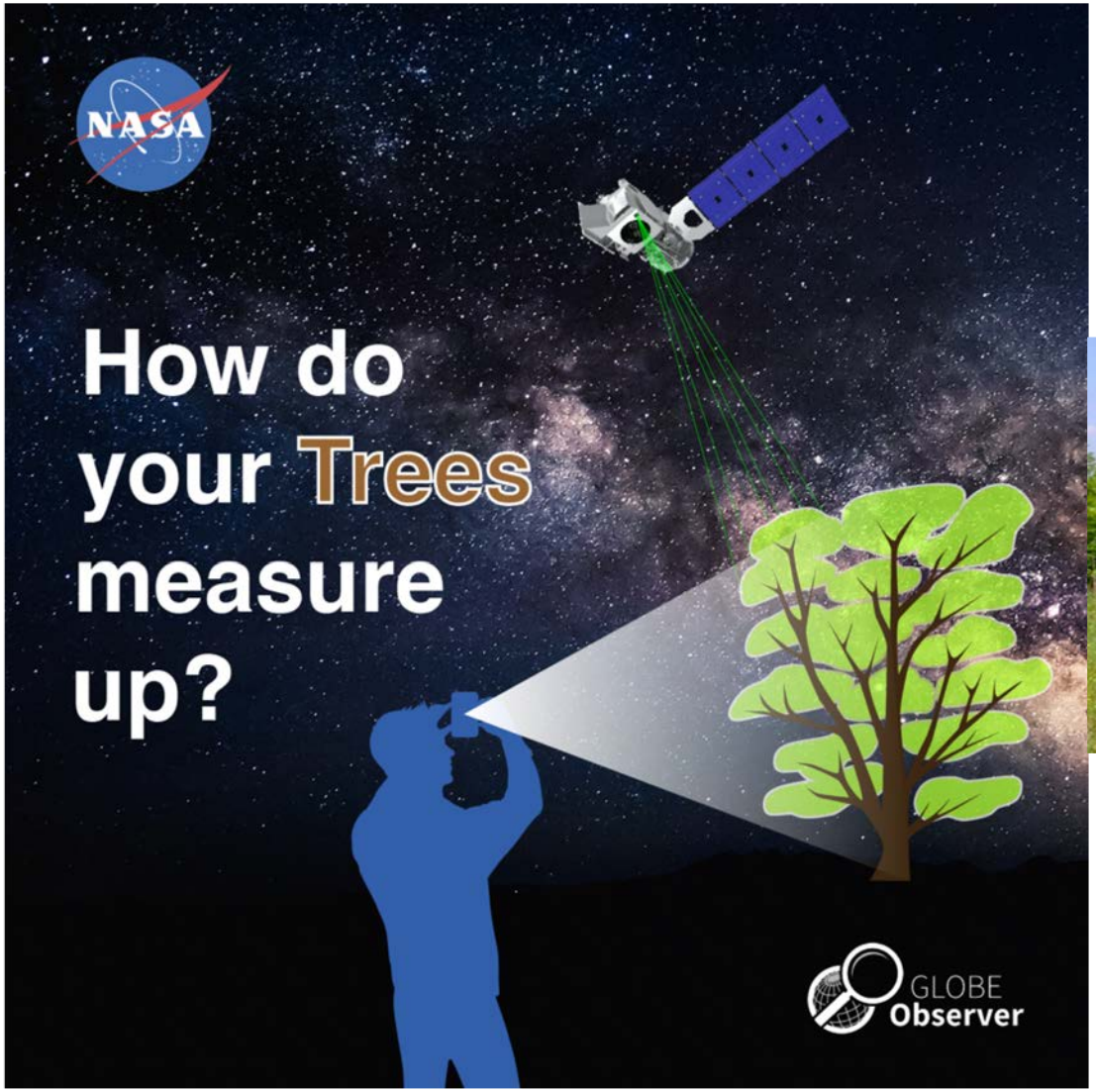
ICESat-2 Website - http://icesat-2.gsfc.nasa.gov/

ICESat-2 on Facebook – https://www.facebook.com/ICESat2

GEDI Mission - https://gedi.umd.edu/

Trees Campaign - https://www.globe.gov/web/trees-around-the-globe

NASA GLOBE Observer - http://observer.globe.gov



LET'S GO OUTSIDE AND MEASURE SOME TREE HEIGHT!

CONTACT INFORMATION

Brian Campbell

NASA Senior Outreach and Communications Specialist
ICESat-2 Mission Team
Trees Science Lead
Trees Around the GLOBE Campaign Lead

NASA Wallops Flight Facility
Wallops Island, Virginia USA

Brian.A.Campbell@nasa.gov